Paper presented in the IV Globelics Conference at Mexico City, September 22-24 2008

Competition and innovation: allies or foes? A case study of Indian manufacturing sector

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1.0 Introduction

The fundamental building block of the economic theory of competition is that the most ideal condition of competition is represented by perfect competition. It refers to a situation in which the market is characterized by the presence of a large number of sellers selling homogenous products. Economists held the view that perfect competition was the best possible market structure in which an optimal resource allocation could be achieved (Cohen and Levin, 1989). Also, this interpretation of competition suited the static view of competition of the early periods of the evolution of the concept of competition. However, this view was severely shaken in 1942 when Schumpeter opined that, " the atomistic firm operating in a competitive market may be a perfectly suitable vehicle for static resource allocation, but the large firm operating in a concentrated market was the most powerful engine of progress and….long run expansion of output." The major aspect of this view was that it marked a major shift from the static to dynamic conceptualization of competition.

In a dynamic setting, competition needn't necessarily be characterized by a large number of players. Instead, competition is characterized by the presence of players who have the potential to innovate and keep their rivals up on their toes. In this scenario, players who have the ability to innovate find that their production costs fall resulting in them able to capture a greater market share. Meanwhile, the players who are unable to innovate fail to survive in the market resulting in them leaving the market. The result in innovation plays a key role in reducing the number of market players in a particular good resulting in the creation of a concentrated market structure. To the proponents of a static competition framework, this would indicate a sure sign of a fall in competition. However, the dynamic competition theorists opine that a concentrated market structure can indicate a substantial degree of competition among the few players in operation. The emergence of greater competition in concentrated market structure resulting in innovation which plays a crucial role in a

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country's long term economic growth was a direct challenge to the antitrust orthodoxy prevalent during that time.

1.1 Problem of the study

The conflict between competition and innovation as posed by the Schumpeterian notions stimulated extensive empirical research trying to determine the relation between competition and innovation in various sectors of the economy. India was no exception to this and several seminal piece of works have already been carried out in this area and which will be reviewed in Section 2.2. In all these studies, it can be observed that the variable used to denote innovation is the Research and Development intensity. In fact, research expenditure has emerged as the most important quantifiable measure of research effort that is used in empirical studies (Subodh, 2002). It is widely considered as a logical as well as a direct measure of innovation. However, R&D expenditure is an input measure of innovation and all &D expenditure need not result in innovative activity. This input measure suffers from certain defects. A basic problem is that R&D intensity depends on the industrial mix. Within an industry, there tends to be wide distribution of R&D intensities among firms. So, it is very common to find high R&D firms in low R&D industries and vice-versa (Smith, 2005). Apart from this R&D expenditure also contains a certain proportion of acquired technology. Acquired technology is calculated as the R&D embodied in capital and intermediate goods used by an industry, and is computed via the most recent input-output table. Smith (2005) showed that acquired technology as a proportion of direct R&D expenditure rose dramatically when there was a move from high to low-tech industries. This, according to the author, suggested that technology intensity was likely to be very sensitive to how the measurement of acquired technology was carried out.

Innovation can be measured via both input measures as well as via output measures. The most important output measure of innovation is the patent count. A patent is the public contract between an inventor and a government that grants time-limited monopoly rights to the applicant for the use of technical invention. One of the most important advantages of patent measure is that it is granted for inventive technologies with commercial promises. This makes patent counts a better measure of innovation rather than R&D intensity. However, patent count is also not without its share of issues. A major one is that the economic value of patents is highly heterogenous and a great majority of patents are never exploited commercially (Kamien and Schwartz, 1982; Cohen and Levin, 1989). It has also been observed that many innovations are never patented. Kamien and Schwartz (1982) also point out that patents are used for major as well as minor innovations and giving equal weights for both is inappropriate. However, taking into account such qualifications, empirical literature based on the analysis of patent data has proven to be highly useful in mapping the inventive activity over long time periods, assessing the impact of economic factors on the rate of invention, elucidating the complexity of technology bases in large firms, the mapping of inter-industry technology flows and in the analysis of spill-over of knowledge using patent citations (Smith, 2005).

Since reforms, the official policy of the Government of India has been to promote competition and innovation in the Indian industries. One sector where there has been a considerable thrust on both these aspects has been the manufacturing sector. There has been a large amount of empirical literature which has taken into consideration the relation between competition and innovation in Indian manufacturing sector. However, almost all the literature[4] considered R&D expenditure as the measure of innovation. The present study takes a diversion at this juncture. The study takes into account the patent data as the proxy for innovation and then determines how competition has had an influence on innovation.

2.0 Review of literature

One of the seminal works in the Indian context which tried to examine the case of competition and innovation for the first time was Subrahmanian (1971[a]). The study examined the case of Indian chemical industries and found that there existed no positive relationship between firm size and R&D intensity. However, in a later paper by the same author (1971[b]), additional variables like profits, retained earnings, depreciation, gross investment and lagged R&D expenditure were taken into consideration and it was found that absolute R&D expenditure is positively related to size. Lall (1983) found that innovation in Indian engineering industries is positively related to size, age and technical absorptive capacity. Lall opined that the major reason for this positive relation is that the industries in developing countries have not yet reached a threshold size beyond which the relation between R&D and size will become negative. The findings of Lall were however contradicted by Katrak (1985) who showed that the elasticity of R&D expenditure with respect to sales was less than unity. This indicated that there was no significant relation between innovation and size. However, Kathuria (1989) showed that this result of Katrak might be due to the data set that he employed which was basically a mix of different industries unlike Lall who studied specifically for engineering industry. Siddharthan (1988) showed that the R&D and firm size has a U-shaped relation and the threshold sales level was at Rs.600million. This study therefore had findings which were distinctively different from that of Lall and Katrak. Kumar (1987) showed that R&D intensity is negatively related to concentration. This was attributed to the fact that the Indian industries usually tend to get concentrated on account of the government policy which protects firms from both domestic as well as import competition. As a result the firms in concentrated market structures did not have absolutely any initiative to undertake innovative activities. One of the first studies to follow a different trend from that of existing literature was that of Deolalikar and Evenson (1989). Using the patent data they tried to determine, the status of innovation in Indian manufacturing sector. They also reported a negative relation between innovation and firm size. However, Subodh (2002) opined that since India had a very weak patenting regime, the patent data was unreliable and therefore the results were not reliable.

In the post-reform era there has been a greater degree of realization regarding the need for innovation as far as the Indian industries are concerned. This has become

[4] Except for the study by Deolalikar and Evenson(1989)

more so since in the post-libaerlaization phase, the Indian firms are becoming increasingly exposed to foreign competition which necessitates the firms to innovate so as to survive the competition. In this context the studies by Subrahmaniam (1996) and Prasad (1999) assumes significance. Both these studies reported a positive and significant relation between firm size and in-house R&D. Subodh (2002) provided an interesting result. Examining the case of drugs and pharmaceutical industries, the study reported that the firm size showed a non-linear (inverted U) significant relation between with both the decision as well as intensity of innovative activity for both set of industries. However, it was also shown that there was an insignificant negative relation between market concentration and innovation. The post reform period also saw some advancements being made in applying new measures used to describe innovation other than the widely used R&D expenditure. A few of the prominent studies in this angle was the one by Siddharthan and Krishna (1994) where technology import was proxied for innovative activity. Another study was by Basant (1996) where innovation was proxied with both technology imports as well as own R&D.

From the literature examined above, it is clearly evident that innovation in Indian literature is still based on R&D expenditure and recently on variables such as technology imports. Output measures such as patents are not being used to measure innovation in the Indian context. However, the dynamics of technology evolution over time could be of prime concern to India if market initiated reforms have to be garnered for accelerating economic growth (George, 2005) . To capture this technology evolution, patent is a more appropriate measure than R&D expenditure.

3.0 Empirical estimation

3.1 Analytical Framework

Having identified the lacunae in the empirical literature, the study now attempts to develop an empirical model which aims at determining the impact that competition in Indian manufacturing industries has had on innovation in the sector measured using the patent count. The study primarily examines the relationship between patent counts as proxies or innovation activities and the effect of competition and R&D on it. By patent counts, we mean the number of patent granted to various firms in the industries during a given year. The industries taken into consideration for the study were chemical industry, drugs industry, electrical industry, mechanical industry and food industry and the time period under consideration was from 1998-99 to 2004-05. The industry selection were restricted to these industries since the patent data was available only for these. Similar was the reason for the selection of the time period. The patent count was obtained from the various issue of the Annual Reports published by Intellectual Property India. The patent grants given to the selected industries for the time period under consideration is given in table (1).

Table 1: Patents Granted to selected manufacturing industries

Year	INDUSTRIES				
	Chemical	Drugs	Electrical	Food	Mechanical
1998-99	609	150	138	35	462
1999-2000	516	307	147	250	569
2000-01	353	276	142	72	254
2001-02	483	320	139	36	311
2002-03	399	312	118	67	228
2003-04	609	419	396	110	539
2004-05	573	192	245	67	414

Source: Annual Reports, Intellectual Property India

Research and Development Intensity (RDI) for each industry was calculated as the ratio of Research and Development expenditure to total sales of that industry. Patent is an outcome of the Research and Development expenditure incurred in an enterprise. But, there is a lag involved in the relation. The patent granted today would be a result of the research and development expenditure incurred during a previous period. In order to account for this lag, the RDI has been taken with a 5 year lag. However, there needn't necessarily be a linear relation between research and development and patents. This is because research and development expenditure can be incurred for activities other than innovation like for instance, adapting a technology that has been developed elsewhere to suit Indian conditions. But, patents are an outcome of the research and development activity that the firm incurs and without undertaking this expenditure, patents cannot be obtained. The data was obtained from CMIE-PROWESS data base.

The measures of competition comprised of both the presence of foreign competition in the domestic market as well as the degree of domestic competition among domestic firms. While the former was measured using import penetration ratio, the latter was captured by Hirschman-Herfindahl Index (HHI). Import penetration ratio (IMPR) for each industry was defined as follows:

IMPR= (Total imports of the industry)/ (Total sales of the industry- Exports of the industry+ Imports of the industry)

HHI of each industry is defined as the sum of the square of the market share of the sales of each firm in the industry. The database used for the calculation of both these measures was CMIE-PROWESS data base.

Having elaborated on the variables used in the study, we now proceed to the methodology used for the analysis. The number of patents produced by any industry is defined as a function of R&D intensity (RDI) and competition- both domestic competition (measured by Hirschman-Herfindahl index-HHI) as well as foreign competition (measured by import penetration ratio-IMPR). Therefore,

$$(\text{Patent count})_{it} = f(\text{RDI}_{it}, \text{HHI}_{it}, \text{IMPR}_{it}) \quad \ldots\ldots(1)$$

where *i* is the industry and *t* is the year.

The literature on competition and innovation clearly illustrate the fact that the relationship between the two is non-linear in nature. The nature of non-linearity is such that at lower levels of competition, the levels of innovation tends to be higher whereas at higher levels of competition, innovation levels tend to be lowered. The rationale behind this view is that when the competition levels are higher, the market is characterized by the presence of a large number of incumbent firms. These incumbents in all probability might be facing neck-and-neck competition if they are at the same level of technology. Therefore, in order to escape this competition, the incumbent players will innovate new products and production processes so as to get a larger share of the market. This innovation is undertaken to escape competition. As competition becomes lower, the rate of innovation declines. After a threshold level, the innovation declines. This is because, at this stage it is the laggard firms which undertake innovation and they already have very low profit levels. The result is low levels of innovation. This view has been reinforced through the empirical works of Aghion et al (2005) wherein which they derived a inverted u-shaped demand curve while plotting competition (measured by Lerner index) against innovation (measured by patent counts). So as to capture this non-linear relation between patent and innovation, the present study is employing an exponential model[5].

$$y_{it} = \exp(\beta_0+\beta_1 HHI_{it}+\beta_2 IMPR_{it}+ \beta_3 RDI_{it} + u_{it}) \quad \ldots\ldots(2)$$

where, y_{it} = patent count granted to i^{th} industry during t^{th} time period.
HHI_{it} = domestic competition in i^{th} industry during t^{th} time period.
$IMPR_{it}$ = foreign competition in domestic market in i^{th} industry during t^{th} time period.
RDI_{it}= research and development intensity i^{th} industry during t^{th} time period.
u_{it} = error term.

The equation to be estimated can be derived from equation (2) by taking natural log on either side of the eqation. Therefore,

$$\ln y_{it} = (\beta_0 + \beta_1 HHI_{it} + \beta_2 IMPR_{it} + \beta_3 RDI_{it} + u_{it}) \ln e$$

Since ln e=1

$$\ln y_{it} = \beta_0 + \beta_1 HHI_{it} + \beta_2 IMPR_{it} + \beta_3 RDI_{it} + u_{it} \quad \ldots\ldots(3)$$

The model was subjected to simple OLS regression. The results are given in the next session.

[5] A similar approach can be found in Uchida and Cook (2007)

3.2 Empirical Findings

Table (2) presents the results of the OLS regression.

Table 2: Regression results

Variables	ln y_{it}
Intercept	4.084* (12.363)
HHI	0.343** (2.418)
RDI	0.575* (4.143)
IMPR	0.664* (4.801)
R^2	0.506
No. of observations	3091

Note: Figures in brackets shows the t-values
*Significant at 1% **Significant at 5%

3.2.1 Relationship between the level of innovative activity and the spending on Research and Development

The regression results shows that RDI has got a significant and positive impact on innovative activity. Higher the spending on research and development, greater seems to be the patents counts. The result is obvious. However, if one considers the fact that the RDI in the post reform period has declined compared to the pre-reform period, it seems to indicate that it is not the quantum of money that is spend on R&D that determines innovation in the economy, but it is the productivity of the R&D spending that would result in the innovation output such as patents. Thus, the results suggests that in the post reform period, the R&D spendings are not only for adaptive innovation but for innovation activities that are of patentable nature.

3.2.1 Relationship between the level of innovative activity and domestic competition

Table 2 shows that the level of domestic competition as measured by HHI has a positive and significant impact on the levels of innovation in an economy. This indicates that higher the value of HHI, greater is the level of innovation in the Indian manufacturing sector. This finding therefore supports the hypothesis put forward by Schumpeter on a positive relationship between firm size and innovative activity. The fact that competition levels in the Indian manufacturing sector hasn't really witnessed increasing competition levels in the post reform era has been well established by a large number of studies[6] especially of recent times. Theoretically, concentrated

[6] See for example Pant *et al* (2005), Pushpangadan *et al* (2006), Balakrishnan *et al* (2006).

market structures provide incentive to prospective innovators to innovate and the empirics show that this view is applicable in the Indian context.

3.2.3 Relationship between the level of innovative activity and import penetration

IMPR has a positive and significant impact on the patent counts. This indicates that as the foreign competition increases in the domestic market, the level of innovation in the domestic market tends to increase. It is only by innovating and introducing new products into the market that the domestic enterprises can withstand the foreign competition. With the reforms of 1991, the Indian economy has been opened up and there is an increased entry of new players into the market. The protection granted to the domestic players have been steadily reduced. In this scenario, the domestic players have realized that only through efficiency and innovation can they continue to survive in the market. This fact is borne out by the result.

4.0 Conclusion

The study examined the relationship between market structure and innovation. It has been observed that in the Indian scenario, innovation measured by patent counts has been positively and significantly influenced by domestic competition, import penetration as well as by research and development. The study is constrained by the fact that the years under consideration is limited to 7 years due to the paucity of patent data. Inspite of this limitation, the study makes a deviation from the existing Indian literature on market structure and innovation by proxying innovation on the basis of patent counts rather than on R&D expenditure. The rationale for considering patent counts was that from 2005, India in order to be TRIPS compliant had amended the Indian Patent Act of 1970 to introduce process patenting along with product patenting. It is widely believed that this would be a major challenge to the Indian industries (especially pharmaceutical industry) who till now enjoyed tremendously the benefits of reverse engineering. Studies pointed out that the new patent regime would make it difficult for Indian players to compete with the foreign players across various manufacturing segment since the foreign players enjoy a distinct advantage in the area of innovation. Whether these worries are misplaced or not can be known only in the near future. However, the situation prior to 2005 indicate that foreign competition hasn't had a negative impact on the level of innovation in the Indian manufacturing sector. It has also been observed that domestic competition as measured by HHI has been having a positive and significant impact on innovation. This suggests that the more concentrated the industry the greater will be the level of innovation. Thus, it can be concluded from the present empirical exercise that competition and innovation are more of foes and less of allies in the Indian manufacturing sector.

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